AC 2009-370: STANDARDS EDUCATION IN TECHNOLOGY PROGRAMS

Amin Karim, DeVry University

Amin Karim is the Director of Academic Outreach at DeVry University. Immediately prior to this position, he served as the Director of the College of Technology for approximately eight years at the university. He is a past Chair of the Electronics and Computer Engineering Technology Department Heads Association and served as a TAC of ABET evaluator for engineering technology programs. He also served as a member of the Standards Education Committee for IEEE and the Global Wireless Education Consortium (GWEC) Executive Board.

Jennifer McClain, IEEE

Jennifer McClain has been with the IEEE for eleven years. She spent eight years with the IEEE Standards Association aiding working groups in the standards development process, editing and publishing standards, and as the Managing Editor of the Standards Information Network, publishing handbooks and guides to help with the implementation and understanding of standards. She currently works for IEEE Educational Activities as the Program Manager for IEEE Standards Education developing online tutorials, case studies and other resources for students, educators and practicing professionals.

Standards Education in Technology Programs

Abstract

During the past two decades, business and trade have been strongly influenced by information technology and globalization. The business environment is extremely competitive in which international standards and standardization systems are playing an increasingly important role in all areas including technology, finance, trade and environmental law. As a result, the ability to apply technical standards has become an essential skill for engineers and technologists. Engineering accreditation criteria require students to acquire "an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability". This criterion implies learning about Regulations and Standards. However, the TAC of ABET General Criteria currently does not have a similar requirement for technology programs. A 2008 survey conducted by the Center for Global Standards Analysis indicated that Standards Education does have a strategic value. This paper presents DeVry University's initiative for educating its technology students on global standards and standardization systems. It also discusses the IEEE Standards Education Committee's effort on developing educational material to help learn Standards. A sample student application paper is exhibited.

Introduction

Standards and codes are a very important part of the practice of engineering and technology. Since products and services are increasingly being developed and delivered from various parts of the world, knowledge and application of standards have become even more crucial. Almost all world trade is affected by standardization. Many businesses will not consider buying products or services that do not meet applicable or common standards for performance, safety and quality. Concerns about sustainability also require products and processes developed according to global standards. The findings of a recent survey conducted in March-July 2008 by the Center for Global Standards Analysis indicated that "standards education is necessary and does have a strategic value" (1). Those surveyed represented 11 major standards organizations from the U.S.A., U.K., China and Japan.

However, although knowledge of standards should be integral to engineering and technology education, standards education is still generally acquired after students graduate from college – in their professional lives and as needed. Private corporations, government agencies and other professional organizations have provided this training for the last century, because most engineering and technology programs in the United States do not have standards education in their curriculums. In the college curriculums, consideration of standards has been generally limited to applications in the design of senior projects.

The Engineering Accreditation Commission (EAC) of ABET has taken a step to require standards education by including appropriate language in its criteria. This paper discusses the knowledge and skills requirements of undergraduate technology graduates and proposes a model for standards education for technology curriculums. It also describes the academic resources that have been developed over the last five years under the leadership of the Institute of Electrical and Electronics Engineers (IEEE) Standards Education Committee and discusses current projects as well as those under way.

Who Are the Stakeholders of Standards and Regulations?

Before attempting to define the universe of standards education, it is worthwhile to examine the evolution of international standardization and identify all stakeholders and constituents. In an article, Prof. Shiro Kurihara has proposed a Three-Wave Model for the spread of international standardization (2). The first wave is driven by scientists, engineers, and technologists; during this phase standards for technologies, products, manufacturing processes, and services are defined. The second wave started approximately two decades ago because of the application of network and digital technologies in communications. The main stakeholders in this phase are the corporation and business leaders who are interested in the development of standards and procedures for interoperable technologies to facilitate world trade. This phase takes approximately five years and is not suitable for products with shorter lifecycles. The third wave is driven by government and consumers and typically involves standards for services and for product maintenance to improve customer safety and satisfaction. This phase has necessitated the development of global standards and regulations in other areas, such as accounting, law, health, environment and safety. The three waves are interrelated and input from each phase is fed back to the other phases leading to continuous improvement. In summary, the role of standards has significantly expanded since the creation of the Internet and the World Trade Organization, leading to increased impact on business and society, and creating many more stakeholders.

Domain of Standards Education for Technologists

In 2003, a group of industry engineers and educators led by Dr. Ted Bickart (Former Chair of the Accreditation Policy Council of the IEEE Education Activities Board) and Gerald Peterson (Former President of IEEE Standards Association) formed a Standards in Education Task Force to identify knowledge and skills in standards that engineers and technologists should acquire before graduation. The process included faculty and student surveys to identify the current state of standards education. The task force recommended the following:

1. Engineering and technology graduates should receive a comprehensive introduction on standards. This includes information on how standards are developed, how they impact the development of product, process, or service and how they benefit a country's economy.
2. Graduates should be familiar with key standards organizations in their disciplines and study standards or regulations in the context of an engineering case study.

3. Graduates should be able to identify and apply relevant standards in solving the expectations of an engineering design.

The IEEE task force also coordinated the development of significant educational materials to help engineering and technology programs incorporate standards education.

Implementation of Standards Education at DeVry University's North Brunswick Campus

Several universities including DeVry University at North Brunswick implemented standards education in the curriculum of their engineering or technology programs. A 3-step process was used to implement standards education at DeVry. The first step was to incorporate consideration of standards in the list of program outcomes of the electronics engineering technology (EET) program. In order to assess the effectiveness of standards education, one of its program outcomes was modified to include the following language:

- *An ability to apply creativity in the design of systems, components, processes or services to meet desired needs incorporating multiple realistic constraints and technical standards, and appropriate to program educational objectives*

The second step was to modify course objectives to require learning of technical standards in two courses.

- In an early-term EET course, students acquire basic knowledge of standards using an IEEE-developed tutorial. A Web-based mastery exam is used as an assessment tool.
- In a mid-program course, students learn about how to use relevant standards such as IEEE 1391, USB, Bluetooth, and 802 in engineering solutions. Several case studies (developed by the IEEE taskforce) demonstrating application of standards are used as reference material. Students are also required research and identify standards from other organizations that could have been used in solving the case study problems. A written paper justifying the use of standards in the case study problems is used for assessment of student learning.

As the final step, in the senior project course, students are required to select and solve an engineering design problem that incorporates the realistic constraints of technical standards. Assessment and evaluation of this step validate student learning and lead to continuous improvement of standards education in EET. During the initial pilot, the IEEE provided access to its professional standards materials to students and faculty at no cost. A student application paper written by a Network and Communications Management senior project team at DeVry – North Brunswick may be viewed at the IEEE Standards Education Website: http://www.ieee.org/portal/cms_docs_iportals/iportals/education/setf/Applications/DeVry_Student_Application_paper_%28Nov2006%29.pdf

Current IEEE Initiatives

The Standards in Education Task Force obtained funding from the IEEE and the National Science Foundation (NSF) to develop web-based standards-related educational resources. Today, the Standards Education Committee (SEC) oversees the work. This joint standing committee is comprised of volunteer members from the IEEE Standards Association and IEEE Educational Activities Board, bringing members from industry and academe together for common goals.

The mission of the SEC is to: (1) Promote the importance of standards in meeting technical, economic, environmental, and societal challenges; (2) secure and disseminate learning materials on the application of standards in the design and development aspects of educational programs; (3) secure and provide short courses about standards needed in the design and development phases of professional practice; and (4) actively promote the integration of standards into academic programs.

To support this mission, a web portal, standardseducation.org, is providing resources to help introduce and teach undergraduate and graduate students, as well as educators, about technical standards by providing free access to online tutorials, case studies, standards reference directory and glossary, as well as a gateway to educational information about technical standards for a worldwide audience. These resources aim to be of use in the classroom in order to help incorporate the teaching of standards into curricula, however they are also helpful to practicing professionals who may be new to standards.

Online tutorials and case studies are available with many more under development. The tutorials provide a high-level overview, general knowledge, and understanding about standards and standards development focusing on a family of standards (i.e., networking, design automation, power standards, etc.), including the characteristics of the various categories of standards in the family. More in-depth tutorials will be offered in order to provide a deeper understanding about standards in a specific category or subset of standards and how the requirements of each subset impact product and process design. Each tutorial will offer a quiz at the end that provides immediate feedback for the student. The case studies describe the selection and application of relevant standards to a domain of products and/or processes, illustrated by particular standards conforming products and/or processes in the market.

To further support the mission of the SEC, IEEE mini-grants are offered for undergraduate and graduate students, and their faculty mentors, working on capstone or graduate design projects with an industry standards component. The results are published by the IEEE as Student Application Papers. Students interested in this opportunity submit a short application along with a summary of their project and a Statement of Endorsement from a faculty mentor. As a result of this initiative, the Standards Education Committee received approximately 10 new applications from students (U.S. and non-U.S.) for the mini-grants we are offering for Student Design

Projects and Student Application Papers. To date, eight proposals have been approved. Standards being addressed by students in their projects and papers include:

- Wireless standards, IEEE 802.11™ (WiFi), IEEE Std 802.15.1™ (Bluetooth®), IEEE Std 802.15.4™ (ZigBee®), IEEE Std 802.16™ (WiMAX)
- Ethernet standards, such as IEEE Std 802.3™ and IEEE Std 802.1™
- IEEE 11073™ Standards for Health Informatics

In October 2008, the SEC conducted a Standards Education survey of just over 1,000 IEEE members. The survey included practicing engineers from all regions of the world in technical sectors such as power, computers, software, and communications. Seventy-five percent of respondents indicated that technical standards were important to very important in their technical fields. Twenty-two percent indicated that they learned to apply technical standards at their university, while the majority reported that they learned from a mentor while working on a specific project that required the use of a particular standard or standards, or were self-taught.

Conclusions and Recommendations

In this global economy, formal study of standards and regulations has become essential to technologists. The authors recommend that all undergraduate technology programs embed standards study into the curricula. Graduate study of standards should include the impact of standards on policy and decision issues. Finally, corporations and government agencies should train professionals on how to develop the best standards, as the economies of all nations depend on the collective ability to develop and maintain an effective international standards system.

References:

1. Purcell, Donald E. Editor. "The Strategic Value of Standards Education." The Center for Global Standards Analysis, August 2008. (For a copy of the Center's survey report, contact donpurcell@strategicstandards.com .)
2. Kurihara, Shiro. "Foundations and Future Prospects for Standards Studies: Multidisciplinary Approach." International Journal of IT Standards and Standardization Research, Vol. 6, No. 2, July-August 2008.